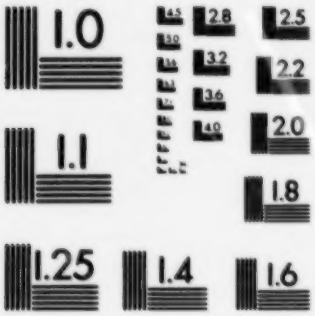
MS109

Micromedia Limited



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

This statement was filmed with this document.
If the pages of the document are less clear
than this statement it is due to the poor
photographic quality of the document.

NATIONAL MICROGRAPHICS ASSOCIATION

24x

MINERALOGY AND PREDICTIVE METALLURGY OF THE TALLY POND PYRITIC MASSIVE SULPHIDE DEPOSIT, BUCHANS AREA, NEWFOUNDLAND

by

J.L. Jambor
Mineralogy Section
Mineral Processing Laboratory

December 1984

This document is an unedited interim report prepared primarily for discussion and internal reporting purposes. It does not represent a final expression of the opinion of the Canada Centre for Mineral and Energy Technology (CANMET)

Ce document est un rapport provisoire non-révisé et rédigé principalement pour fin de diffusion et de documentation interne. Il ne représente nullement l'expression définitive de l'opinion du Centre canadien de la technologie des minéraux et de l'énergie (CANMET)

Project MRP-5.3.9.9.99
Cost Recovery

Job No. 025208S

MICROMEDIA

MINERAL RESEARCH PROGRAM
MINERAL SCIENCES LABORATORIES
DIVISION REPORT MRP/MSL 84-17 (CR)

CONFIDENTIAL

DECLASSIFIED
DATE 30/09/86
AUTHORIZED BY

39 pp

MINERALOGY AND PREDICTIVE METALLURGY OF THE TALLY POND PYRITIC MASSIVE SULPHIDE DEPOSIT, BUCHANS AREA, NEWFOUNDLAND

by

J.L. Jambor*

ABSTRACT

The Tally Pond deposit near Buchans in central Newfoundland contains about 450,000 t of pyritic massive sulphides grading about 3% Cu and 3% Zn distributed in three zones designated the North, South, and Southeast. Chalcopyrite and sphalerite account for the Cu and Zn; the chief source of the modest silver values in the deposit is hessite (Ag_2Te), and low grades of Pb are present as galena. Supergene alteration in the form of digenite and covellite is weak and spatially restricted in the North and Southeast zones, but the South Zone has been affected to the extent that unacceptably low metal recoveries are anticipated. Liberation of the chalcopyrite and sphalerite in the North Zone sulphides should be at economically satisfactory levels, and excellent liberation is projected for the Southeast Zone sulphides.

---

*Research Scientist, CANMET, Energy, Mines and Resources, Canada, 555 Booth Street, Ottawa K1A 0G1

CONTENTS

INTRODUCTION 1

GENERAL MINERALOGY..... 5
Pyrite..... 5
Sphalerite, chalcopyrite, galena..... 7
Other sulphides..... 8
Other minerals..... 9

NORTH ZONE..... 10
Drillholes 35 and 41..... 11
Drillholes 30, 32, 33..... 16
Summary..... 20

SOUTH ZONE..... 22
Summary..... 26

SOUTHEAST ZONE..... 27
Summary..... 30

CONCLUSIONS..... 31

ACKNOWLEDGMENTS..... 33

REFERENCE..... 33

APPENDIX..... 34

INTRODUCTION

The Tally Pond massive sulphide deposit is in central Newfoundland, about 35 km southeast of Buchans (Fig. 1). The property is held jointly by Noranda Exploration Company Limited and Abitibi-Price Incorporated, with Noranda as the operator. The area is underlain principally by coarse felsic volcanic breccia which is part of the Ordovician Victoria Lake Group (Swinden and Kean 1984).

Pyritic massive sulphides have been intersected in several diamond-drill holes in three areas designated the North Zone, the Southeast Zone, and the South Zone (Fig. 2). Possibly these zones represent sulphide deposition peripheral to a central dome

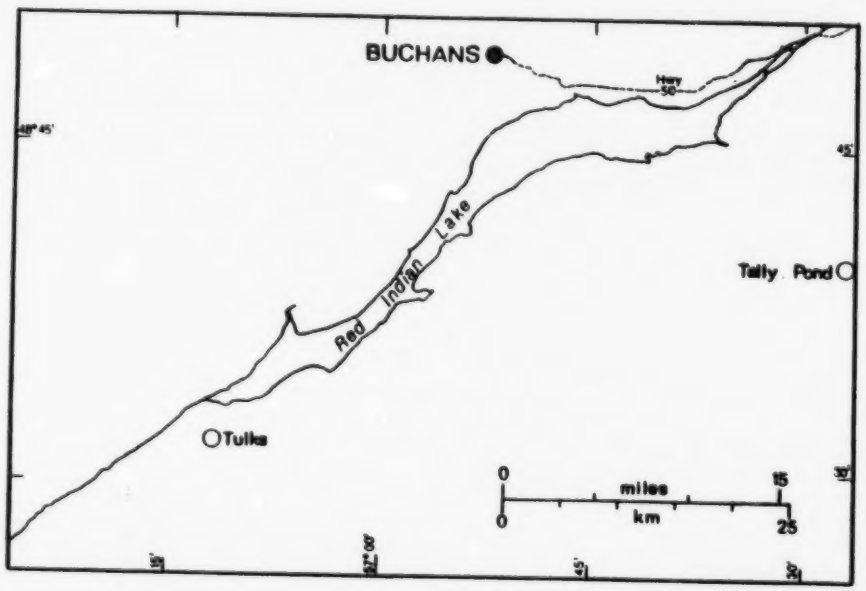


Fig. 1 - Location of the Tally Pond deposit, central Newfoundland.

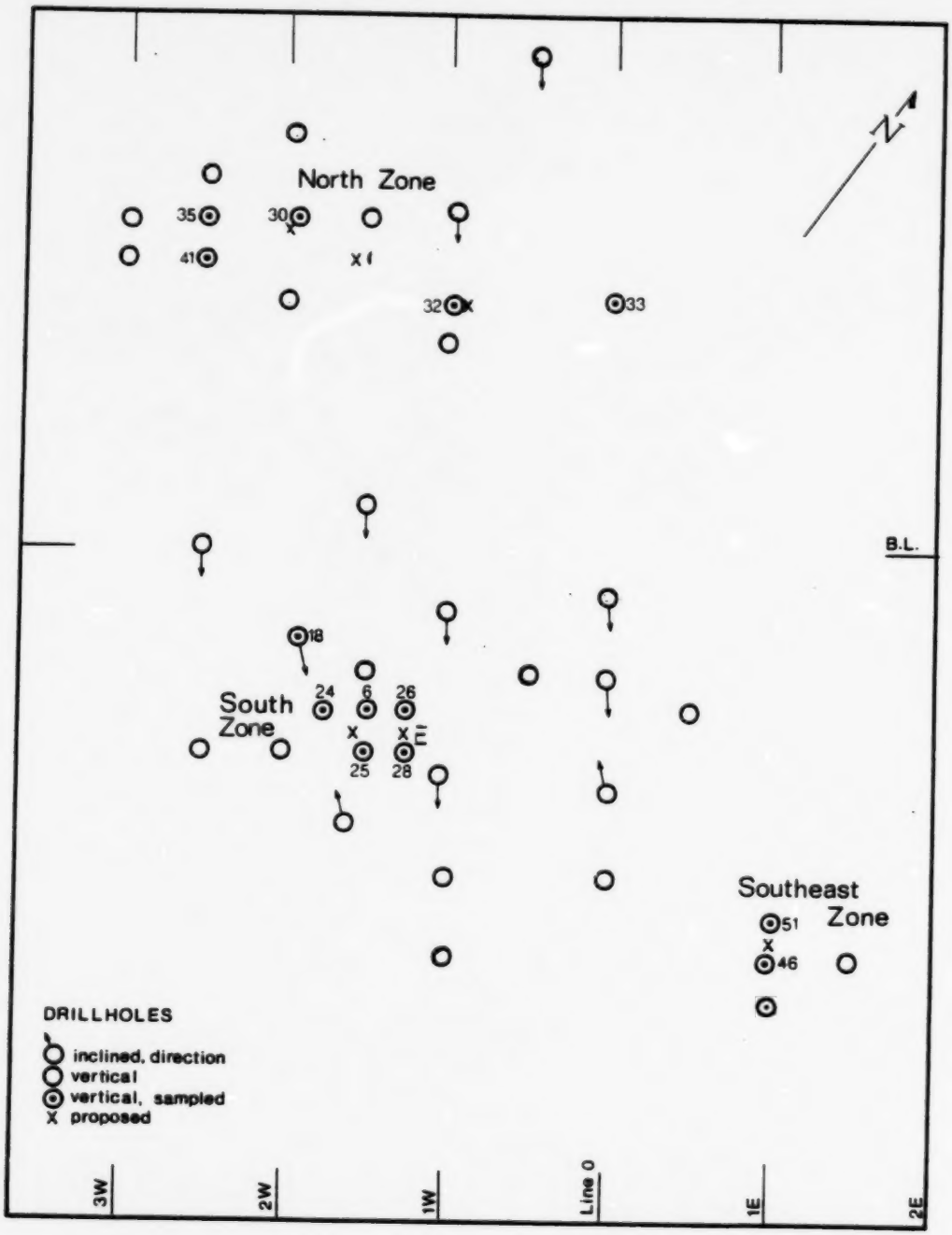


Fig. 2 - Location of the drillholes sampled for this study and designation of the Tally Pond sulphide zones. Grid spacing is in units of 100 meters.

structure. Geological correlations are based mainly on the assumed continuity of massive sulphides intersected in drillholes; the continuity, however, has not been demonstrated unequivocally and thus even the interpretation of the basic geological framework is tenuous. Although additional drilling is necessary to establish firmly the geometry of the sulphide lenses, current assumptions are that three or four discontinuous massive lenses are present and in aggregate contain about 450,000 t grading approximately 3% zinc and 3% copper, with low values in lead and silver, and negligible gold. About three quarters of this tonnage is in the North Zone, which has an above-average copper grade but lower than average grades of zinc and silver.

Although the Tally Pond deposit is relatively small, it is of current interest as a potential short-term source of feed for the mill at Buchans. Mining of the deposit would be by open pits, with haulage by truck to Buchans.

The present study was undertaken to determine the mineralogical character of the Tally Pond sulphides and to assess whether metallurgical difficulties might be encountered in processing the ore. In a previous study by D.J.T. Carson[1],

---

1. Company memorandum, July 6, 1984: Predictive Metallurgy of 12 Drill Core Specimens from the Tally Pond Deposits; Noranda Exploration Company Limited, Toronto.

twelve core samples were examined microscopically and it was concluded that the zinc and copper in the Tally Pond ores should give satisfactory metallurgical responses; it was cautioned, however, that the twelve specimens examined were above-average in metal grades and thus might not be representative, and that porous spheroidal pyrite observed in some of the samples might prove troublesome to flotation if this type of pyrite is abundant and widespread. It was recommended that determination of the extent of porous pyrite in the deposit, and testing of the metallurgical response of this type of material be given top priority in future work.

To obtain the broader mineralogical assessment of the ores, the writer and Noranda Exploration personnel D.J. Carson, D. Fitzpatrick, and C. MacKenzie visited the property on October 23, 1984, and resampled the massive sulphide intersections at approximately 0.5 m intervals (Appendix I). Additional samples were taken from a trench which exposed the massive sulphides near drillhole 6 in the South Zone.

The results reported below are based on a microscopic examination of 173 polished sections and 11 thin sections. The mineralogical study was reconnaissance rather than detailed, commensurate with the objective of obtaining an overview in a short period of time. Thus only minimal supplementary work was done by electron microprobe and X-ray powder diffraction.

GENERAL MINERALOGY

PYRITE

The Tally Pond massive sulphides consist largely of pyrite, and the base-metal values reflect the presence of sphalerite, chalcopyrite, and galena. The pyrite varies from fine-grained framboidal (Fig. 3) to coarse euhedral grains more than 1 mm along an edge. Most of the pyrite occurs as crystals and polycrystalline aggregates, but colloform textures, growth zones in crystals, and framboidal masses are common. Lamination of the massive sulphides occurs mainly in North Zone samples, and in these much of the layering arises from the alternation of framboidal layers versus those rich in pyrite crystals and base metal sulphides. Whereas the North Zone contains abundant framboidal pyrite, the opposite extreme is represented by the Southeast Zone wherein only individual framboids or small clusters were occasionally seen but no framboidal layers were observed.

Other textural features of the pyrite are mentioned in the description of the sulphides of the North Zone. Particularly notable is that many of the coarse pyrite grains in the Tally Pond deposit have undergone in-situ brecciation as is indicated by the matched grain boundaries of separated fragments. Also notable is that appreciable amounts of pyrite in the deposit consist of grains deposited as sedimentary debris (Fig. 4). Some features of the pyrite, such as undeformed framboids (single as

Fig. 3 - Sulphide layering arising from contrasting textures and mineral assemblages: top layer consists mainly of framboidal pyrite with the finer grained framboidal matrix blackened from acid etching; bottom layer consists of pyrite crystals in a chalcopyrite (cp) matrix. Reflected light, oil immersion. Drillhole 35 at 25.4 m (North Zone). Bar scale represents 0.05 mm.

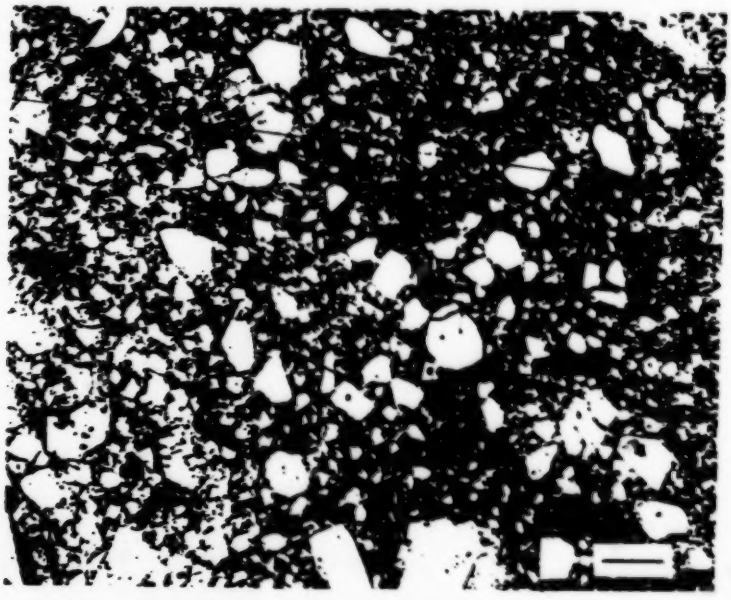


Fig. 4 - Angular detrital pyrite fragments in a fine-grained pyrite-rich matrix. Reflected light, oil immersion. Drillhole 32 at 13.6 m (North Zone). Bar scale represents 0.05 mm.

well as groups), delicate colloform textures, and intricate growth zones indicate a lack of metamorphic recrystallization. In contrast, some samples contain coarse-grained, euhedral crystals with sieve-texture inclusions, and other samples contain polycrystalline pyrite aggregates with triple-joint grain boundaries; these features are indicative of strong metamorphic recrystallization. The distribution of the contrasting textures might be useful in assessing or delimiting the role of local dynamic metamorphism, but this aspect was not pursued.

Sphalerite, chalcopyrite, galena

Sphalerite and chalcopyrite occur chiefly in the interstices among pyrite grains, and chalcopyrite in particular is commonly a veinlet mineral in fractured pyrite. Both minerals also occur as megascopic patches and streaks containing only minor amounts of other minerals. Some of the core pieces from the South and Southeast zones consist largely of massive sphalerite accompanied by only a few per cent pyrite; this type of occurrence was not observed in samples from the North Zone.

Microprobe analyses of sphalerite in two samples gave iron contents ranging from 2.2 to 4.6 wt % (Table 1). Most of the sphalerite throughout the deposit is free of emulsion-type bleb inclusions of chalcopyrite (commonly referred to as the "chalcopyrite disease"). Intergrowths of this type are widespread but are volumetrically small because of their absence

Table 1. Microprobe compositions of sphalerite

		Southeast Zone drillhole 46, 16.6 m			South Zone drillhole 25, 19.9 m		North Zone drillhole 35, 30.8 m		
		1*	2	3	1	2	1	2	3
wt %	Zn	62.4	62.1	62.2	64.5	64.4	64.5	64.4	64.2
	Fe	4.6	4.4	4.6	2.2	2.1	2.3	2.4	2.3
	Cd	0.3	0.3	0.3	0.1	0.1	0.2	0.3	0.2
	S	32.9	33.2	33.0	33.3	33.1	33.0	33.0	33.1
		100.2	100.0	100.1	100.1	99.7	100.0	100.1	99.8

*Different areas in the same polished section.

in coarse-grained sphalerite and their erratic presence in fine grains. The strongest and most persistent occurrences of the chalcopyrite disease are in the Southeast Zone.

Galena is present in the majority of Tally Pond samples, usually as only a low fraction of a percentage of the sulphides, and usually as fine-grained intergrowths locked in pyrite. In the few assay intervals with lead contents exceeding 2%, the galena is predominantly coarser grained and a high proportion is in clean grains amenable to separation.

OTHER SULPHIDES

Pyrrhotite occurs only as bleb inclusions in coarse-grained pyrite. Most of the blebs are about 5 µm in diameter; the

largest is 60x30 μm. Arsenopyrite is rare and has been noted to be present in only two samples, one from the North Zone and the other from the South Zone. No tetrahedrite was found in the present study. Marcasite was not observed; X-ray powder diffraction patterns of spheroidal porous pyrite showed these to be homogeneous rather than fine-grained mixtures of pyrite and marcasite.

Covellite and digenite are locally abundant supergene alteration products whose distributions are discussed in detail in the descriptions of each sulphide zone. Minute amounts of enargite are associated with the secondary copper sulphides in a few samples. The enargite occurs mainly as thin rims around pores in altered chalcopyrite, and as thin seams along the middle of covellite veinlets.

OTHER MINERALS

Blebs and laths of tellurides, up to 40 μm in longest dimension, occur in galena in several specimens and less commonly in sphalerite and chalcopyrite. The tellurides are altaite (PbTe), hessite (Ag_2Te), an unidentified bismuth telluride, and two other phases whose homogeneity is questionable: a lead-bearing bismuth telluride and a lead-bearing silver telluride. Many of the telluride grains are complex intergrowths, and no attempt has been made to further specify the mineral species. It

is significant, however, that the local presence of silver tellurides in the polished sections shows an extremely good correlation with the assay intervals highest in silver. As no other silver minerals have been found in the deposit, the conclusion is that hessite is the principal silver ore mineral.

Seams and particles of graphite were observed in a few polished sections, especially those with framboid-rich layers from the North Zone. The seams parallel the layering and are up to 30 µm wide and 500 µm long.

The principal non-sulphide minerals are chlorite, muscovite, quartz, siderite and dolomite. Needles and aggregates of rutile are common wherever silicate minerals are present. The North Zone massive sulphides have an extremely low non-sulphide content consisting mainly of interstitial siderite and dolomite.

NORTH ZONE

Possible configurations of the drill-intersected massive sulphides in the North Zone are shown in Figures 5 and 6. Sulphides intersected in drillholes 35 and 41 (Fig. 2) indicate a moderate northerly dip in this area, but whether this attitude continues toward the west is not known with assurance. Continuity between the eastern and western parts of the North Zone is not proven.

Many of the massive sulphide samples from the North Zone consist almost wholly of tightly packed sulphides. This feature, which is a manifestation of very low non-sulphide gangue contents, is so characteristic of North Zone sulphides that their megascopic polished surfaces alone are usually sufficient to distinguish these polished sections from those of the southern sulphide zones.

DRILLHOLES 35 AND 41

The eastern extremity of the North Zone is represented by drillholes 35 and 41 (Fig. 2). About 0.3 m of massive sulphides were intersected at bedrock surface in drillhole 35 (Fig. 5),

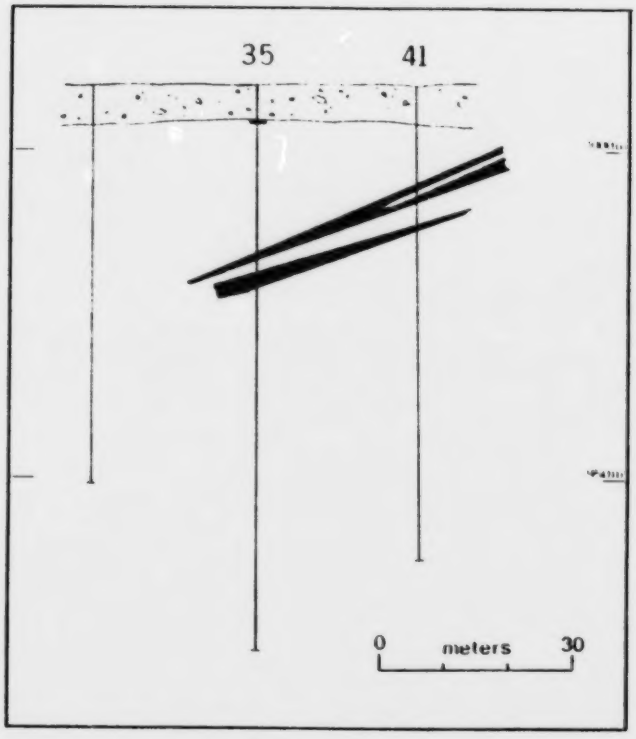


Fig. 5 - Cross-section at the eastern end of the North Zone showing the possible configuration of the massive sulphides (black) intersected by drillholes 35 and 41.

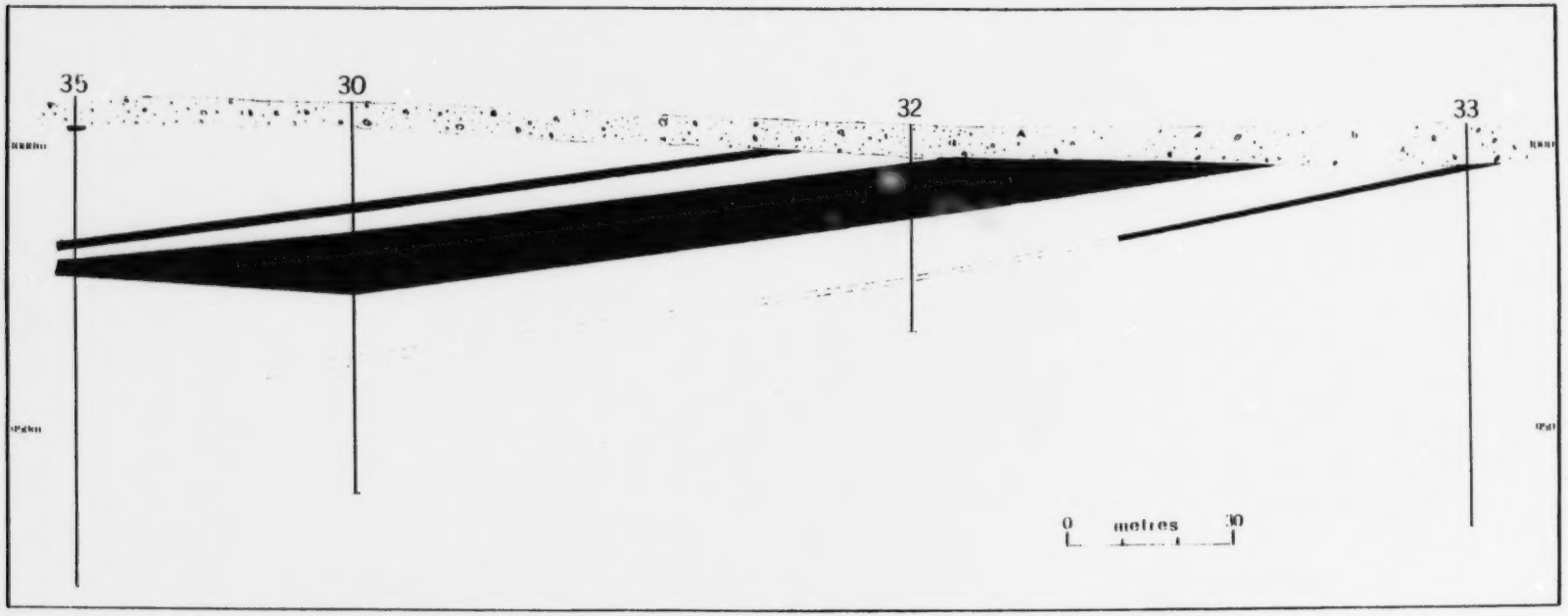


Fig. 6 - Longitudinal cross-section showing the possible configuration of the sulphides in the North Zone. The continuity and attitudes of the sulphide intersections are conjectural.

but were not sampled for this study. The first of the deeper intersections consists of tightly packed massive sulphides showing a moderate degree of layering. The sulphides are succeeded downhole by lapilli tuff containing sulphide-barren lithic fragments in a sulphide-rich matrix in which detrital pyrite fragments, 1 to 2 mm in longest dimension, are evident. The deepest sulphide intersection in the hole has virtually the same sequence described above, that is, the sulphide unit seems to have been repeated. This repetition, combined with drillhole logs by Noranda Exploration which indicate bedding dips of 70 to 90° to the core axis, suggests that possibly the structural configuration is completely different from that shown in Figure 5.

Microscopic examination of polished sections of cores from the two main sulphide intersections in drillhole 35 confirms their megascopic similarity in textures even though metal grades differ markedly: the sample from the first intersection at 25.4 m contains abundant chalcopyrite and sphalerite, whereas only chalcopyrite is abundant in the second intersection at 28.7 m. Both samples have been supergene-altered as indicated by hairline veinlets and rims of digenite and covellite in chalcopyrite, and by the presence of rare patches of digenite up to 40 μm in diameter. That the alteration is weak is evident from the thinness of the veinlets and rims, which are generally 1-2 μm

wide, and their erratic, localized occurrence in only minor parts of individual polished sections.

Variations in abundances of chalcopyrite and sphalerite contribute to sulphide layering, but the main derivation of this feature is the alternation of pyritic layers with different habits and grains sizes of pyrite, especially where framboid-rich layers are present. The framboidal layers generally contain relatively large, individual well-formed framboids in a finer-grained polyframboidal matrix which is less acid-resistant than the single, coarser framboids (Fig. 7).

Complete replacement of framboids by chalcopyrite has been observed, but intricate partial replacement is rare; usually the chalcopyrite occurs in clean patches amidst the framboids. Also noticeable is that the framboid-rich layers are typically sparse in ore minerals, especially sphalerite, even where the ore minerals are abundant in adjacent layers (Fig. 3)

Framboid-rich layers commonly appear to be slightly porous, and careful microscopic examination at high magnification has shown that at least some of the inter-framboid black areas consist of films and specks of graphite. As well, a few microscopic seams of graphite, parallel to the sulphide layering, were observed in the massive sulphides from both drillholes (35 and 41). Whether the fine porosity associated with some

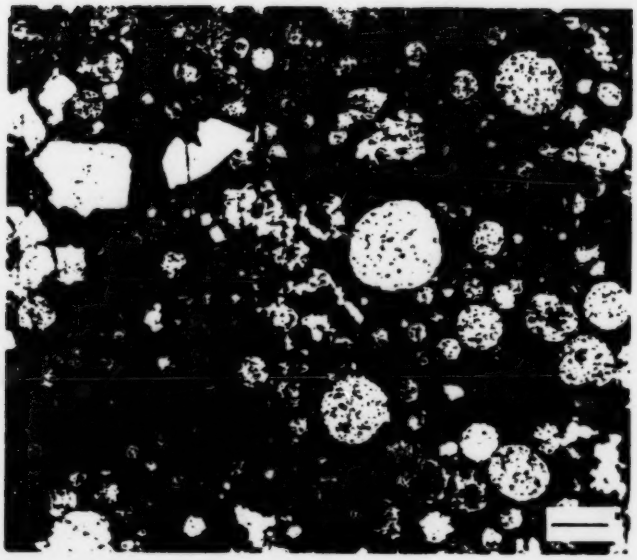


Fig. 7 - Well-formed single framboids in a diffuse polyframboidal matrix more readily attacked and darkened by acid etching. Reflected light, oil immersion. Drillhole 35 at 28.7 m (North Zone). Bar scale represents 0.002 mm.

framboids is associated with the presence, or former presence, of carbonaceous material is not known but is a possibility worth noting if processing difficulties arise.

The main ore mineral in drillholes 35 and 41 is chalcopyrite which, where abundant, forms a matrix containing crystals and inclusions of pyrite. Matrix chalcopyrite is gradational to interstitial chalcopyrite, that is, pyrite is predominant in abundance and chalcopyrite is mainly in the interstices among the pyrite grains. Sphalerite occurs principally as grains of irregular outline in chalcopyrite and has few inclusions of pyrite. Galena is present only in small amounts in the massive zones, predominantly as inclusions in pyrite crystals and in

complex intergrowths concentrated along the growth layers of various forms of zoned pyrite. A high proportion of the galena will be non-recoverable.

The massive sulphide zones in drillholes 35 and 41 are gradational to silicate-rich rocks in which the sulphide contents vary from about 10% to almost massive (~70%). Lithic fragments are evident in some samples, and much of the sulphide content is detrital rather than primary synsedimentary. Samples from drillhole 41 are more abundant in sulphides and framboidal pyrite than those from drillhole 35. Metal grades also are highly variable in the silicate-rich zone; for example, the polished section from drillhole 35 at 30.1 m contains about 50% sulphides but only traces of sphalerite, chalcopyrite, and galena, all of which are locked as blebs in coarse pyrite crystals. In contrast, the sample taken at 30.8 m contains only about 20% sulphides, but these consist of sparse disseminated pyrite in abundant, coarse-grained sphalerite, chalcopyrite, and galena. Within the galena are scattered blebs of altaite up to 25x50 μm.

DRILLHOLES 30, 32, 33

Drillhole 30 intersected an upper zone of 1.7 m of massive sulphides, and a lower zone which is 11.1 m thick but is partly silicate-rich rather than massive. The upper intersection consists of typical North Zone tightly packed massive sulphides, though here the sulphides are not laminated and framboids are

almost absent. The pyrite occurs mainly as fractured, coarse-grained aggregates with exceptional individual crystals up to 1 mm along an edge. Chalcopyrite is the main ore mineral, and it and the associated sphalerite occur mainly in sharply-bounded fractures in the pyrite. Most of the sphalerite is clean and free of pyrite, but many of the chalcopyrite veinlets attain only hairline widths; as well, some of the chalcopyrite has partly replaced pyrite with the result that the two minerals are fine-grained intergrowths not readily amenable to separation. In the upper part of the sulphide zone only a small fraction of the chalcopyrite and sphalerite are interstitial rather than fracture-controlled, but the proportions change to rough equivalence near the bottom of the zone. Galena content throughout the zone is negligible, but several blebs of hessite and bismuth telluride occur in chalcopyrite in the sample from 18.5 m. This sample also contains sparse blebs of covellite and digenite localized along a microscopic fracture. The only other sign of similar alteration was observed in the uppermost sample (17.85 m), where traces of covellite, digenite, and enargite occur as rims on chalcopyrite. The alteration is restricted to chalcopyrite grains in non-sulphide gangue.

In the thick, lower sulphide zone in drillhole 30, approximately the first 4 m of sulphides are massive and generally contain several per cent of both sphalerite and

chalcopyrite. Lamination of sulphides is rare, but occasional crude layering is evident. Chalcopyrite and sphalerite vary from interstitial to veinlet, but almost always there are large, megascopic masses and patches of either mineral that contribute significantly to the high metal grades. Pyrite varies from coarsely crystallized to fine-grained intergrowths; framboidal and colloform porous pyrite are present only locally and are low in overall abundance. Blebs of tellurides in galena occur sporadically from 25.5 to 27 m. Most of the polished sections contain very little galena, a high proportion of which is locked as replacement intergrowths with pyrite.

The massive sulphides described above are succeeded by a silicate-rich zone, and lastly by about 1 m of typical, tightly packed massive sulphides consisting of coarse-grained pyrite intergrowths with abundant interstitial and veinlet chalcopyrite, and negligible sphalerite and galena. Samples from the silicate-rich zone have sulphide contents ranging from about 25% to more than 75%. The lowest sulphide contents in this range are represented by host rocks containing fine-grained disseminated pyrite crystals and negligible ore minerals; samples with medium-range sulphide contents vary from those in which sulphide abundance has been diluted by chloritic lithic fragments, to those in which much of the sulphide consists of detrital pyrite. Sphalerite and chalcopyrite in all of these rocks occur

predominantly as relatively coarse-grained patches and veinlets readily amenable to liberation; galena is sparse and much of it, together with a small amount of sphalerite, occurs as non-recoverable inclusion blebs in pyrite.

Nearly all of the samples from drillhole 32 (Fig. 6) consist of compact, tightly packed, non-laminated massive sulphides megascopically similar to those at the top and bottom of the main zone in drillhole 30. Supergene alteration in drillhole 32 was not observed in the upper contact sample at 7.0 m; the only alteration seen was at 7.4 m, where traces of covellite-digenite occur at the interface between chalcopyrite and silicates in one part of the polished section.

All of the samples from drillhole 32 contain several per cent chalcopyrite and are almost devoid of galena. Sphalerite occurs more erratically; it is abundant in a few samples but is only a low fraction of a per cent in the large majority. Pyrite is varied-textured in that large crystals, fine-gained crystal aggregates, framboids, colloform rosettes, pyrite detritus, and fragmental pyrite from in-situ brecciation occur throughout the zone, and several of these textures are present in an individual polished section. The pyrite rosettes, although observed in several samples, are not quantitatively abundant and are not significantly porous; most of the microscopic porosity occurs amidst fine-grained matrix pyrite and is unlikely to be a

detrimental factor in processing. Interstitial and veinlet chalcopyrite predominate and should give satisfactory but not exceptional copper recoveries because pyrite-chalcopyrite middlings will arise from local areas in which chalcopyrite is saturated with fine-grained islands of partly replaced pyrite.

Drillhole 33 in the North Zone intersected only 1.1. m of massive sulphides at bedrock surface (Fig. 6). The sulphides are copper-rich, low in other metals, not laminated, and are not sufficiently tightly packed to be immediately recognizable as North Zone samples. Numerous ragged chloritic inclusions similar to those seen in other drillholes, (e.g. 35 at 30.1 m; 25 at 28.1 m) occur amidst the sulphides at the bottom contact.

Pyrite in drillhole 33 occurs mainly as homogeneous euhedral crystals, many of which are 1 to 2 mm along an edge. In-situ brecciation of the pyrite is widespread. Chalcopyrite occurs mainly as veinlets along fractures and between breccia fragments, and also as patches in interstices among the pyrite grains.

SUMMARY

Massive sulphides from the North Zone characteristically consist of compact, tightly packed sulphides. The tight packing is a reflection of the extremely low content of non-sulphide gangue minerals. Supergene alteration, represented mainly by thin rims of covellite and digenite on chalcopyrite, occurs at the tops of both main lenses in drillholes 35 and 41 (Fig. 5), at

the top contact of the thin sulphide zone in drillhole 30 (Fig. 6), and at the initial intersection in drillhole 30. The alteration is weak and sporadic, is confined mainly to a thin zone within about 0.6 m of the sulphide contacts, and seems to decrease from west to east. Even within these thin alteration zones, overall covellite-digenite content averages much less than 0.1 vol %.

Pyrite in the North Zone varies in habit from coarse euhedral crystals to fine-grained polyframboidal masses. Ovoids of porous pyrite resembling "bird's-eye" pyrite occur occasionally but are not sufficiently abundant to be of metallurgical concern. X-ray powder diffraction patterns of the ovoids have not revealed the presence of marcasite, and thus excess acidity derived from the breakdown of fine-grained pyrite-marcasite intergrowths should not be a problem. Of more concern is the presence of small amounts of graphite, here associated principally with framboidal pyrite, which also are known to disrupt normal flotation. Satisfactory metal recoveries from bench-test samples of the upper lens in drillholes 35 and 45 would demonstrate that neither digenite-covellite nor graphite is sufficiently abundant to interfere with normal flotation.

Chalcopyrite is abundant in nearly all North Zone samples; sphalerite is abundant in some samples and merely of incidental presence in many others. Galena is abundant in relatively few

samples, and only in these are the grain sizes and textures appropriate to the attainment of adequate lead recovery; in most samples the galena is not only sparse and fine-grained, but the grains are either locked as non-recoverable bleb inclusions in pyrite, or are in complex intergrowths that will appear as pyrite-galena middlings. It is anticipated that better than 50% Pb recovery will be obtained only from assay intervals which average more than 0.5% Pb.

Chalcopyrite in the North Zone occasionally occurs in large, relatively homogenous patches. By far the commonest forms, however, are veinlets which healed fractured pyrite, and grains which filled the interstices among pyrite grains. In a few cases chalcopyrite replaced pyrite to form fine-grained, sieve-like textures not readily amenable to separation; nevertheless, the highest proportion of chalcopyrite-pyrite middlings will be derived from thin veinlets of chalcopyrite in pyrite. Sphalerite and chalcopyrite are closely associated and usually have simple mutual grain boundaries. Recovery percentages of sphalerite will probably be similar to those of chalcopyrite.

SOUTH ZONE

Six drillholes from the South Zone were sampled (Fig. 2). Drillhole 18, the most easterly in this series, intersected mainly disseminated sulphides, and none of the assay intervals

approaches ore grades. A thin massive zone from 6.0 to 7.0 m was examined in four polished sections, all of which are of massive sulphides lacking the tightly packed feature of North Zone samples. In the three polished sections from 6.0 to 6.7 m, strong supergene alteration is evident from the presence of numerous covellite-digenite rims on chalcopyrite, and from similar alteration of some sphalerite grains. The pyrite is of the varied-texture type with abundant framboids and undesirable fine-gained pyrite-chalcopyrite intergrowths.

Drillhole 24 (Fig. 2) intersected an extensive zone of disseminated sulphides straddling a zone, from 25.4 to 31.5 m, which is described in Noranda Exploration drillhole logs as "massive sulphide with interstitial chlorite". The zone is appreciably below ore grade; the main sulphide is disseminated, euhedral and subhedral single crystals of pyrite. No framboids were seen. The principal ore mineral is chalcopyrite which has various associations (bleb inclusions in pyrite; interstitial to pyrite) but most commonly occurs as irregular patches in the silicate gangue. Traces of sphalerite and galena occur in some samples, and several blebs of tellurides were observed in the one from 20.8 m. Signs of supergene alteration or oxidation were not evident.

The possible configuration of the massive sulphides intersected in drillholes 6 and 25 is shown in Figure 8a. In drillhole 6, the two low-grade massive to semi-massive sulphide

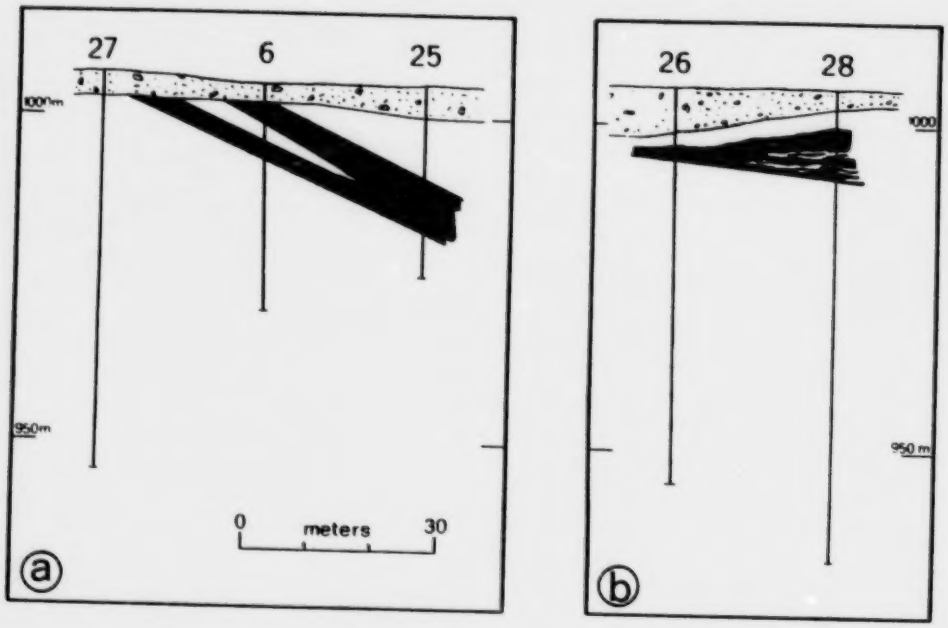


Fig. 8 - Possible configuration of the sulphides in the South Zone.

zones illustrated are reported in the drillhole logs to be separated by approximately 4 m of grey pyroclastics with 40% matrix sulphides. The polished sections of the two sulphide-rich zones have sulphide contents ranging from about 90% to 20%. The only sulphides of potential ore grade occur near the bedrock surface (3.2 to 6.1 m). Microscopic examination has revealed that strong supergene alteration has affected the sulphides from 3.2 to 4.3 m. The alteration is evident from covellite-digenite rims and veinlets which have attacked not only chalcopyrite, but also sphalerite. The sample from 3.8 m contains iron oxides, some of which occurs as rims on sphalerite grains.

Drillhole 25 intersected a thick interval of sulphides (Fig. 8a) which is more uniformly massive, but is preceded by 2.5 m of gossan which gave only 0.3 m of core recovery. Significant covellite alteration is present in all of the massive sulphide samples from 14.3 to 16.2 m, inclusive, and thereafter occurs sporadically to at least 21 m. The highest concentration of covellite is at 15.0 m, where veinlets of the mineral are up to 35 µm wide and 1.5 mm long, and patches with inclusions of pyrite and residual chalcopyrite are up to 1.5 mm in diameter; total volume of the covellite is estimated to be about 4%. At 15.8 m, about 50% of the chalcopyrite grains are rimmed by covellite; the associated sphalerite contains covellite veinlets up to 25 µm wide and 1 mm long, commonly with medial seams of enargite.

The possible configuration of the massive sulphides intersected by drillholes 26 and 28 is shown in Figure 8b. The massive zone in drillhole 26 is 2.3 m thick and has sharp contacts. Sulphides at the upper contact at 8.9 m are unaltered; traces of covellite occur at 0.3 m below the contact, but all other samples appear to be free of alteration. The massive zone contains more than 8% combined Cu+Zn, much of which is present as large homogeneous masses and as coarse interstitial grains. Pyrite is varied-textured; framboids are rare, but fine-grained aggregates of similar size are abundant, as are colloform

textures and rosettes. Bleb inclusions of chalcopyrite in pyrite are common, and substantial amounts of fine-grained sphalerite and chalcopyrite have locally replaced pyrite along growth zones of various types. These features will lower the metal recoveries, which nevertheless should be at acceptable levels because of the contributions from the large homogeneous masses of chalcopyrite and sphalerite.

Drillhole 28 intersected 2.9 m of massive sulphides containing minor sections of host rocks, and an underlying section of 4.8 m which contains numerous sulphide layers (shown schematically in Figure 8b). Only the upper massive sulphide zone was sampled. The initial sample, taken 1.2 m below the upper contact, shows numerous chalcopyrite grains with 1 μm to sub-micron rims of covellite-digenite. Traces of covellite persist, but are mainly supplanted by digenite, in all but the last 0.5 m of the massive zone. Much of the sulphide content of the lower part of the massive zone consists of sphalerite containing coarse, clean, smoothly bounded patches of chalcopyrite and galena. If the detrimental flotation effects of covellite-digenite are suppressed, recoveries of all three minerals should be excellent.

SUMMARY

Current assumptions are that the South Zone contains only 50,000-60,000 t of ore. The microscopic studies have indicated that a significant part of this ore has been affected by

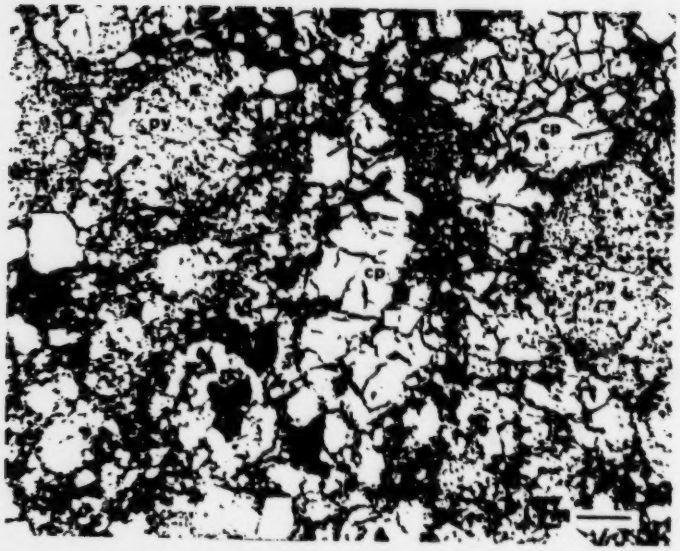


Fig. 9 - Residual chalcopyrite strongly altered by rims and hairline veinlets of covellite which also is present in patches (cv) and is the main dark matrix throughout the areas of pyrite (py). Sample is from the trench in the South Zone. Reflected light, oil immersion. Bar scale represents 0.05 mm.

supergene alteration of sufficient intensity that conventional processing will be rendered ineffective. Examination of samples from a trench which exposed massive sulphide bedrock near drillhole 6 has confirmed that covellite development is locally intense. All of the trench samples show extreme alteration of both chalcopyrite and sphalerite (Fig. 9, 10), commonly to the extent that covellite rather than chalcopyrite is the main source of the copper values.

SOUTHEAST ZONE

The Southeast Zone, represented by intersections in drillholes 46 and 51 (Fig. 2), possibly has the configuration

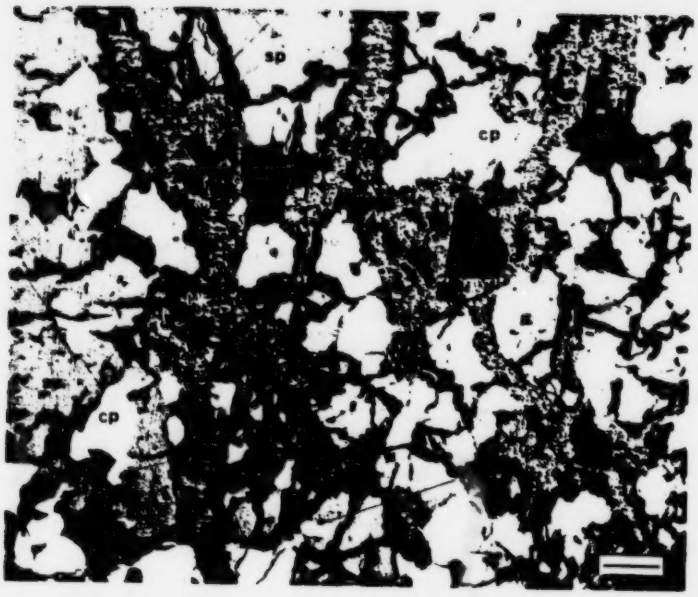


Fig. 10 - Chalcopyrite (white, cp) and sphalerite (grey, sp) extensively replaced by covellite (cv). South Zone trench. Reflected light, oil immersion. Bar scale represents 0.05 mm.

shown in Figure 11. In drillhole 51, an upper zinc-rich sulphide zone is succeeded downward by very low-grade pyritiferous tuff which is in turn followed by a zinc-poor sulphide zone containing about 2% Cu. Of the 26 samples examined in polished sections, all are silicate-rich, and only about a quarter contain sufficient sulphides to be designated as massive, i.e. >70% sulphides. Supergene alteration was not found at the contacts, but digenite veinlets and rims with traces of associated covellite have replaced chalcopyrite in the middle of the deeper sulphide intersection; the alteration zone is about 1 m thick and is centred at 27.5 m.

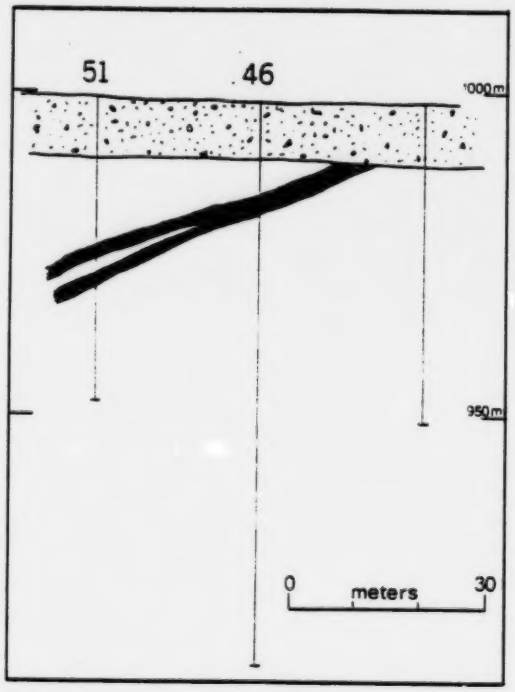


Fig. 11 - Possible configuration of the sulphides in the Southeast Zone.

Some of the pyrite in drillhole 51 occurs as detrital grains which are megascopically conspicuous in the 0.5-1.5 mm size range. Pyrite aggregates fractured in-situ also are common. Framboidal pyrite is absent throughout; the predominant habits are euhedral crystals and anhedral polycrystalline anhedral aggregates. Most of the chalcopyrite and sphalerite occur as patches amidst the pyrite and silicates. Middlings will arise principally from local areas where the chalcopyrite is intergrown with fine-grained pyrite, but no significant problem in attaining satisfactory liberation of the Cu-Zn minerals is anticipated.

Drillhole 46 intersected massive sulphides from about 14.4 to 17.5 m. The interval is notably rich in sphalerite and also

contains substantial amounts of galena and chalcopyrite. Hairline veinlets of digenite accompanied by traces of covellite are present at 15.7 m; covellite and graphite occur along a sulphide layer in the sample taken at 17.4 m. Blebs of silver telluride in sphalerite account for the silver values, which in one assay interval exceed 70g/t. The sulphide zone is low in porous, colloform pyrite and framboidal pyrite. Features detrimental to good ore-mineral recoveries (such as sieve textures, thin fracture fillings, and fine-grained intergrowths with pyrite) occur only locally and are volumetrically small.

SUMMARY

Weak supergene alteration consisting of hairline veinlets and rims of digenite with traces of associated covellite occur in a 1-m interval in drillholes 46 and 51. This alteration is not at the sulphide contacts, but is instead centred in the middle of the sulphide zone in drillhole 46, and in a similar position in the lower sulphide zone in drillhole 51. For the South Zone as a whole, the textures of the ore minerals are simple and the grain sizes are sufficiently coarse to obtain at least 90% recovery of the sphalerite, chalcopyrite, and galena.

CONCLUSIONS

Summaries of the pertinent mineralogical features have been given in the parts of the text which follow the detailed descriptions of each of the three major sulphide zones. From the microscopic studies it is concluded that:

1. The principal ore minerals are chalcopyrite, sphalerite, and galena which are associated with pyrite; only trace amounts of a few other sulphides are present. Hessite is the chief silver carrier; no tetrahedrite has been found in the deposit.
2. Weak supergene alteration represented by covellite and digenite occurs near the contacts of the North Zone sulphides, and at the mid-point of the Southeast Zone sulphide intersections. The content of the secondary copper sulphides is sufficiently low that their detrimental effects probably can be suppressed or overcome.
3. Porous, spheroidal pyrite occurs erratically and is not abundant enough to be a significant factor in processing the ore. Moreover, the spheroids consist of pyrite rather than of potentially troublesome fine-grained pyrite-marcasite intergrowths. Framboidal pyrite is abundant, especially in the North Zone, and the framboids in some cases have minute specks of associated graphite. An interval of framboid-rich sulphides (e.g., the upper sulphide interval in drillhole 41) should be isolated for bench-testing to ensure that graphite is not a problem.

4. In the majority of the assay intervals in the Tally Pond deposit the Pb values are less than 0.5%. A high proportion of the galena in these intervals is locked in pyrite and will not be separable. In galena-rich intervals (>2% Pb) the galena grains sizes are coarser and textures are simpler; only these intervals will give acceptable Pb recoveries.
5. Chalcopyrite and sphalerite in the North Zone occur mainly as interstitial grains and veinlets associated with pyrite; overall liberation of the Cu and Zn minerals should exceed 80%. Four polished sections have been submitted to W. Petruk for image analyses to obtain quantitative information concerning the percentage liberation of chalcopyrite expected from the grind used for the Buchans ore (100% -25 µm). The results, to be reported separately*, will represent <u>minimum</u> liberation because the samples were selected to represent those parts of the North Zone which will give the highest proportion of chalcopyrite-pyrite middlings.
6. The South Zone has been strongly altered by oxidation and covellite replacement; satisfactory flotation response is improbable.
7. The sulphides in the Southeast Zone have the simplest textures and coarsest grain sizes. Chalcopyrite and sphalerite, and probably also galena, should have excellent liberation characteristics.

---

*CANMET, Division Report MRP/MSL 85-1 (CR); 1985.

ACKNOWLEDGMENTS

The cooperation of personnel from Noranda Exploration Company Limited and Abitibi-Price Incorporated made this study possible. Particular acknowledgment is due to D.J.T. Carson of Noranda Exploration for assistance in many ways, including the provision of Noranda's geological maps from which the line drawings in this report are derived. Technical assistance at CANMET was provided by D.R. Owens (microprobe analyses), J.J.Y. Bourgouin and J.M. Beaulne (lapidary), and P. Carriere and E.J. Murray (X-ray diffraction).

REFERENCE

Swinden, H.S. and Kean, B.F. "Volcanogenic sulfide mineralization in the Newfoundland Central Mobile Belt"; In: Mineral deposits of Newfoundland - a 1984 perspective; Mineral Development Division, Department of Mines and Energy, Government of Newfoundland and Labrador, Report 84-3.

APPENDIX 1

SAMPLES STUDIED MICROSCOPICALLY

Samples Studied Microscopically

North Zone

DDH35 - 25.4*
- 25.6
- 25.9
- 26.3
- 26.5
- 28.7
- 29.0
- 30.1
- 30.5
- 30.8
- 31.4

DDH41 - 14.6
- 14.9
- 15.2
- 16.6
- 16.9
- 17.4
- 21.1
- 21.4
- 21.8
- 22.1

DDH30 - 17.85
- 18.1
- 18.5
- 19.1
- 19.4
- 23.6
- 25.0
- 25.3
- 25.5
- 26.1
- 26.6
- 26.8
- 27.0
- 27.5
- 28.0
- 28.3
- 28.7
- 29.0

30 - 29.4
- 29.8
- 30.2
- 30.7
- 31.2
- 32.0
- 32.7
- 33.3
- 33.8
- 34.1

DDH32 - 7.0
- 7.4
- 7.8
- 8.2
- 8.5
- 9.2
- 9.8
- 10.0
- 10.5
- 11.0
- 11.4
- 11.6
- 11.9
- 12.2
- 12.7
- 13.0
- 13.3
- 13.6
- 14.0
- 14.4
- 14.7
- 15.0
- 15.4
- 15.8

DDH33 - 7.4
- 7.8
- 8.0
- 8.4
- 8.5

South Zone

DDH18 - 6.0
- 6.6
- 6.7
- 7.0

DDH24 - 20.8
- 25.0
- 25.8
- 26.5
- 29.6
- 32.6

DDH6 - 3.2A
- 3.2B
- 3.8
- 4.0
- 4.3
- 4.7
- 5.0
- 5.8
- 11.4
- 17.0
- 19.2**
- 19.3
- 19.4
- 19.5
- 19.6
- 20.4
- 21.0

DDH25 - 14.3
- 14.8
- 15.0
- 15.8
- 16.2A
- 16.2B
- 16.8
- 17.4
- 18.0
- 18.5
- 18.8

25 - 19.4
- 19.6
- 19.9
- 20.3A
- 20.3B
- 21.0
- 21.5
- 21.8
- 22.4
- 22.7

DDH26 - 8.9
- 9.2
- 9.8
- 10.3
- 10.8
- 11.2

DDH28 - 7.6
- 7.9
- 8.3A
- 8.3B
- 8.8

Southeast Zone

DDH46 - 14.4
- 14.7
- 15.3
- 15.7
- 16.0
- 16.3
- 16.8
- 16.9
- 17.1
- 17.4

*Drillhole number and depth (in meters)

**Samples 19.2 to 19.6 inclusive are not from the labelled positions but instead represent roughly equal spacing along the 3-m interval from 17.4 to 20.4 m.

DDH51 - 20.0
- 20.8
- 21.1
- 21.5
- 21.9
- 22.5
- 22.8
- 23.1
- 23.4
- 23.8
- 24.0
- 24.3
- 24.7
- 25.1
- 25.3
- 26.0
- 26.3
- 26.6
- 26.9
- 27.2
- 27.5
- 27.9
- 28.2
- 28.5
- 29.0
- 29.9